

What is claimed is:

1. A method of encoding digital data, the method comprising:
bandwidth-extension-encoding the digital data, outputting bandwidth-limited
data, and generating bandwidth extension information;
5 encoding the bandwidth-limited data into a hierarchical structure having a
base layer and at least one enhancement layer so as to control a bit rate; and
multiplexing the encoded bandwidth-limited data and the bandwidth extension
information.

10 2. The method of claim 1, wherein the encoding comprises:
encoding side information corresponding to the base layer;
bit-sliced-encoding a plurality of quantization samples corresponding to the
base layer; and
repeating the encoding and bit-sliced-encoding for a next enhancement layer
15 until a plurality of predetermined layers are completely encoded.

3. The method of claim 1, wherein the encoding comprises:
encoding side information containing scale factor information and coding
model information corresponding to the base layer;
20 bit-sliced-encoding a plurality of quantization samples corresponding to the
base layer with reference to the coding model information; and
repeating the encoding and bit-sliced-encoding for a next enhancement layer
until a plurality of predetermined layers are completely coded.

25 4. The method of claim 1, wherein the encoded bandwidth-limited data
and the bandwidth extension information is multiplexed in such an order that a
portion of the encoded bandwidth-limited data corresponding to the base layer is
located, the bandwidth extension information is located, and portions of the
bandwidth-limited data corresponding to the remaining enhancement layers are
30 located.

5. The method of claim 1, wherein the encoded bandwidth-limited data
and the bandwidth extension information is multiplexed in such an order that the
bandwidth extension information is located, a portion of the encoded

bandwidth-limited data corresponding to the base layer is located, and portions of the bandwidth-limited data corresponding to the remaining enhancement layers are located.

5 6. A method of encoding audio data, the method comprising:
 bandwidth-extension-encoding the audio data, outputting bandwidth-limited
audio data, and generating bandwidth extension information;
 encoding the bandwidth-limited audio data into a hierarchical structure having
a base layer and at least one enhancement layer so as to control a bit rate; and
10 multiplexing the encoded bandwidth-limited audio data and the bandwidth
extension information.

 7. The method of claim 6, wherein the encoding comprises:
 encoding side information corresponding to the base layer;
15 bit-sliced-encoding a plurality of quantization samples corresponding to the
base layer; and
 repeating the encoding and bit-sliced-encoding for a next enhancement layer
until a plurality of predetermined layers are completely encoded.

20 8. The method of claim 6, wherein the encoding comprises:
 encoding side information containing scale factor information and coding
model information corresponding to the base layer;
 bit-sliced-encoding a plurality of quantization samples corresponding to the
base layer with reference to the coding model information; and
25 repeating the encoding and bit-sliced-encoding for a next enhancement layer
until a plurality of predetermined layers are completely coded.

 9. The method of claim 6, wherein the encoded bandwidth-limited audio
data and the bandwidth extension information is multiplexed in such an order that a
30 portion of the encoded bandwidth-limited audio data corresponding to the base layer
is located, the bandwidth extension information is located, and portions of the
bandwidth-limited audio data corresponding to the remaining enhancement layers
are located.

10. The method of claim 6, wherein the encoded bandwidth-limited audio data and the bandwidth extension information is multiplexed in such an order that the bandwidth extension information is located, a portion of the encoded bandwidth-limited audio data corresponding to the base layer is located, and portions of the bandwidth-limited audio data corresponding to the remaining enhancement layers are located.

11. A method of decoding digital data, the method comprising:
demultiplexing an input bitstream and sampling bandwidth-limited data that is encoded into a hierarchical structure having a base layer and at least one enhancement layer and bandwidth extension information;
decoding at least a portion of the bandwidth-limited data corresponding to the base layer; and
generating digital data in at least a portion of a band that is not covered by the decoded portion of the bandwidth-limited data based on the decoded portion of the bandwidth-limited data and with reference to the bandwidth extension information, and then patching the generated digital data to the decoded portion of the bandwidth-limited data.

12. The method of claim 11, wherein the input bitstream is demultiplexed in such an order that data corresponding to the base layer is sampled from the input bitstream, the bandwidth extension information is sampled from the input bitstream, and data corresponding to the remaining enhancement layers is sampled from the input bitstream.

13. The method of claim 11, wherein the input bitstream is demultiplexed in such an order that the bandwidth extension information is sampled from the input bitstream, data corresponding to the base layer is sampled from the input bitstream, and data corresponding to the remaining layers is sampled from the input bitstream.

14. The method of claim 11, wherein the decoding comprises:
decoding side information corresponding to the base layer;
bit-sliced-decoding a plurality of quantization samples corresponding to the base layer; and

repeating the decoding and bit-sliced-decoding for a next enhancement layer until a plurality of predetermined layers are completely decoded.

15. The method of claim 11, wherein the decoding comprises:
5 decoding side information containing scale factor information and coding model information corresponding to the base layer;
bit-sliced-decoding a plurality of quantization samples corresponding to the base layer with reference to the coding model information; and
repeating the decoding and bit-sliced-decoding for a next enhancement layer
10 until a plurality of predetermined layers are completely decoded.

16. A method of decoding audio data, the method comprising:
demultiplexing an input audio bitstream and sampling bandwidth-limited audio data that is encoded into a hierarchical structure having a base layer and at least
15 one enhancement layer and bandwidth extension information;
decoding at least a portion of the bandwidth-limited audio data corresponding to the base layer; and
generating audio data in at least a portion of a band that is not covered by the decoded portion of the bandwidth-limited audio data based on the decoded portion of
20 the bandwidth-limited audio data and with reference to the bandwidth extension information, and then patching the generated digital data to the decoded portion of the bandwidth-limited audio data.

17. The method of claim 16, wherein the input bitstream is demultiplexed in
25 such an order that data corresponding to the base layer is sampled from the input bitstream, the bandwidth extension information is sampled from the input bitstream, and data corresponding to the remaining enhancement layers is sampled from the input bitstream.

18. The method of claim 16, wherein the input bitstream is demultiplexed in
30 such an order that the bandwidth extension information is sampled from the input bitstream, data corresponding to the base layer is sampled from the input bitstream, and data corresponding to the remaining layers is sampled from the input bitstream.

19. The method of claim 16, wherein the decoding comprises:
decoding side information corresponding to the base layer;
bit-sliced-decoding a plurality of quantization samples corresponding to the
base layer; and
5 repeating the decoding and bit-sliced-decoding for a next enhancement layer
until a plurality of predetermined layers are completely decoded.

20. The method of claim 16, wherein the decoding comprises:
decoding side information containing scale factor information and coding
10 model information corresponding to the base layer;
bit-sliced-decoding a plurality of quantization samples corresponding to the
base layer with reference to the coding model information; and
repeating the decoding and bit-sliced-decoding for a next enhancement layer
until a plurality of predetermined layers are completely decoded.

21. An apparatus for encoding digital data, the apparatus comprising:
a bandwidth extension encoder that bandwidth-extension-encodes the digital
data, outputs bandwidth-limited data, and generates bandwidth extension
information;
20 a fine grain scalability encoder that encodes the bandwidth-limited data into a
hierarchical structure having a base layer and at least one enhancement layer so as
to control a bit rate; and
a multiplexer that multiplexes the encoded bandwidth-limited data and the
bandwidth extension information.

22. The apparatus of claim 21, wherein the fine grain scalability encoder
encodes side information corresponding to the base layer, bit-sliced-encodes a
plurality of quantization samples corresponding to the base layer, and
bit-sliced-encodes side information and a plurality of quantization samples
30 corresponding to a next enhancement layer until a plurality of predetermined layers
are completely encoded.

23. The apparatus of claim 21, wherein the fine grain scalability encoder
encodes side information containing scale factor information and coding model

information corresponding to the base layer, bit-sliced-encodes a plurality of quantization samples corresponding to the base layer with reference to the coding model information, encodes side information containing scale factor information and coding model information corresponding to a next enhancement layer until a plurality of predetermined layers are completely encoded, and bit-sliced-encodes a plurality of quantization samples corresponding to the next enhancement layer.

24. The apparatus of claim 21, wherein the multiplexer multiplexes the encoded bandwidth-limited data and the bandwidth extension information in such an order that a portion of the encoded bandwidth-limited data corresponding to the base layer is located, the bandwidth extension information is located, and portions of the bandwidth-limited data corresponding to the remaining enhancement layers are located.

25. The apparatus of claim 21, wherein the multiplexer multiplexes the encoded bandwidth-limited data and the bandwidth extension information in such an order that the bandwidth extension information is located, a portion of the encoded bandwidth-limited data corresponding to the base layer is located, and portions of the bandwidth-limited data corresponding to the remaining enhancement layers are located.

26. An apparatus of encoding audio data, the apparatus comprising:
a bandwidth extension encoder that bandwidth-extension-encodes the audio data, outputs bandwidth-limited audio data, and generates bandwidth extension information;
a fine grain scalability encoder that encodes the bandwidth-limited audio data into a hierarchical structure having a base layer and at least one enhancement layer so as to control a bit rate; and
a multiplexer that multiplexes the encoded bandwidth-limited audio data and the bandwidth extension information.

27. The apparatus of claim 26, wherein the fine grain scalability encoder encodes side information corresponding to the base layer, bit-sliced-encodes a plurality of quantization samples corresponding to the base layer, and

bit-sliced-encodes side information and a plurality of quantization samples corresponding to a next enhancement layer until a plurality of predetermined layers are completely encoded.

5 28. The apparatus of claim 26, wherein the fine grain scalability encoder encodes side information containing scale factor information and coding model information corresponding to the base layer, bit-sliced-encodes a plurality of quantization samples corresponding to the base layer with reference to the coding model information, encodes side information containing scale factor information and
10 coding model information corresponding to a next enhancement layer until a plurality of predetermined layers are completely encoded, and bit-sliced-encodes a plurality of quantization samples corresponding to the next enhancement layer.

15 29. The apparatus of claim 26, wherein the multiplexer multiplexes the encoded bandwidth-limited data and the bandwidth extension information in such an order that a portion of the encoded bandwidth-limited data corresponding to the base layer is located, the bandwidth extension information is located, and portions of the bandwidth-limited data corresponding to the remaining enhancement layers are located.

20 30. An apparatus for decoding digital data, the apparatus comprising:
 a demultiplexer that demultiplexes an input bitstream and samples bandwidth-limited data that is encoded into a hierarchical structure having a base layer and at least one enhancement layer and bandwidth extension information;
25 a fine grain scalability decoder that decodes at least a portion of the sampled bandwidth-limited data corresponding to the base layer; and
 a bandwidth extension decoder that generates digital data in at least a portion of a band that is not covered by the decoded portion of the bandwidth-limited data based on the decoded portion of the bandwidth-limited data and with reference to the
30 bandwidth extension information and the patches the generated digital data to the decoded portion of the bandwidth-limited data.

 31. The apparatus of claim 30, wherein the fine grain scalability decoder decodes side information corresponding to the base layer, bit-sliced-decodes a

plurality of quantization samples corresponding to the base layer, and decodes side information corresponding to a next enhancement layer until a plurality of predetermined layers are completely decoded, and bit-sliced-decodes a plurality of quantization samples corresponding to the next enhancement layer.

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32. The apparatus of claim 30, wherein the fine grain scalability decoder decodes side information containing scale factor information and coding model information corresponding to the base layer, bit-sliced-decodes a plurality of quantization samples corresponding to the base layer with reference to the coding model information, decodes side information corresponding to a next enhancement layer until a plurality of predetermined layers are completely decoded, and bit-sliced-decodes a plurality of quantization samples corresponding to the next enhancement layer with reference to the coding model information.

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33. The apparatus of claim 30, wherein the demultiplexer demultiplexes the input bitstream in such an order that data corresponding to the base layer is sampled from the input bitstream, the bandwidth extension information is sampled from the input bitstream, and data corresponding to the remaining enhancement layers is sampled from the bitstream.

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34. An apparatus for decoding audio data, the apparatus comprising:
a demultiplexer that demultiplexes an input audio bitstream and samples bandwidth-limited audio data that is encoded into a hierarchical structure having a base layer and at least one enhancement layer and bandwidth extension information;

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a fine grain scalability decoder that decodes at least a portion of the bandwidth-limited audio data corresponding to the base layer; and

a bandwidth extension decoder that generates audio data in at least a portion of a band that is not covered by the decoded portion of the bandwidth-limited audio data based on the decoded portion of the bandwidth-limited audio data and with reference to the bandwidth extension information and then patches the generated audio data to the decoded portion of the bandwidth-limited audio data.

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35. The apparatus of claim 34, wherein the fine grain scalability decoder decodes side information corresponding to the base layer, bit-sliced-decodes a plurality of quantization samples corresponding to the base layer, and decodes side information corresponding to a next enhancement layer until a plurality of
5 predetermined layers are completely decoded, and bit-sliced-decodes a plurality of quantization samples corresponding to the next enhancement layer.

36. The apparatus of claim 34, wherein the demultiplexer demultiplexes the input bitstream in such an order that data corresponding to the base layer is sampled
10 from the input bitstream, the bandwidth extension information is sampled from the input bitstream, and data corresponding to the remaining enhancement layers is sampled from the bitstream.

37. The apparatus of claim 34, wherein the demultiplexer demultiplexes the
15 audio input bitstream in such an order that the bandwidth extension information is sampled from the input audio bistream, data corresponding to the base layer is sampled from the input audio bitstream, and data corresponding to the remaining layers is sampled from the input audio bitstream.